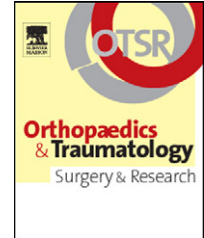




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## REVIEW ARTICLE

# Fracture-dislocations of the femoral head

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### KEYWORDS

Hip dislocation;  
Sciatic nerve palsy;  
Chiron classification;  
Osteoarthritis;  
Avascular necrosis

**Summary** This review describes bone and nerve injury mechanisms during a femoral head fracture-dislocation and outlines a novel classification system that uses computed tomography scanning (CT scan) to help determine how to best treat these fractures in an emergency setting or in chronic cases. A series of 55 cases with CT scan performed in the emergency department (ED) and an average follow-up of 9 years (range 3–13) was used as a basis to develop the classification system; this system takes into account the size of the fragments and any associated acetabular wall or femoral neck fractures. The suggested course of action is based on the CT scan results after the hip joint is reduced. Conservative treatment is indicated every time the head fragments and any potential acetabular wall fragments are properly reduced and there are no foreign bodies (37.7%). Osteochondral head fragments below the fovea must be removed (36.3%). Fragments that are one-third or one-quarter of the head size can either be removed (7.2%) or reduced and fixed (5.4%). A novel medial approach is described that provides minimally invasive access to the anterior-inferior part of the femoral head, which should extend the indications for preservation of one-third head fragments. If the femoral neck is also fractured or a one-half head fragment exists in elderly patients, a total hip replacement should be considered right way (9%). At the latest follow-up, osteoarthritis was present in 43.7% of cases, but was mostly well tolerated – 94% of patients had a WOMAC score between 80 and 100 with signs of osteoarthritis visible on radiographs. Paradoxically, avascular necrosis (9%) is due to small head fractures. The results of our series are compared with the few series that have been published since CT scanning has been systematically used in the ED.  
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Femoral head fracture-dislocations make up only a small portion of hip trauma cases, and are also relatively rare when compared to the number of isolated dislocations and

dislocations associated with fracture of the posterior wall of the acetabulum; they make up 6 to 15% of posterior and anterior dislocations [1,2].

In most cases, the injury is due to high-energy trauma during a motor vehicle accident in a younger subject. The combination of both injuries results in joint stiffness and osteoarthritis [3]. The course of action when faced with these fractures is not well defined. Only about 15 papers

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have been published on this subject in the past 10 or so years, and they typically are small patient series or clinical case reports. The exception is the 110 case "Getraum" series, which includes the 55 cases evaluated by computed tomography (CT) scanning that make up this current observation [3].

Helical (or spiral) cone beam CT has been performed systematically in the emergency department (ED) since 1995. It has allowed us to confirm the diagnosis and specify the size and position of femoral head fragments [4]. Based on this information, we have proposed a modernized surgical classification system for these fractures. The goal was to guide the thinking of an inevitably inexperienced surgeon who must choose an appropriate treatment in the ED without recourse to books [5]. Knowledge of all the surgical approaches for the hip and the medial approach described here allows the surgeon to access an anterior-inferior head fragment to either remove it or to reduce and fix it [6].

We will review bone and nerve injury mechanisms, various classification systems, the approach to take in an emergency setting and how to deal with chronic fracture cases.

## Methods

The series consisted of 55 patients injured between 1995 and 2008 with a minimum follow-up of 3 years; these were mostly young men (87.2%, 45 men, 10 women) with an average age of 37.5 years (range 16–71). Motor vehicle accidents caused the injury in 89% of cases; sport injuries (mostly rugby) and fall from a height were the cause of the other 11%. In 91% of cases, the fractures happened in combination with a posterior dislocation. All the injuries were caused by high-energy trauma; 67% were polytrauma patients and 60% also had an associated acetabulum fracture. The average follow-up for this series was 9 years (range 3–13).

## Injury mechanisms

### Bone injury mechanisms

The size of the femoral head fragment, its position and the potential for associated injuries are directly related to the mechanism of injury. The mechanism is the dashboard, with the hip flexed; this results in a high-energy axial compression of the femur from its distal end to its proximal end; the forces are then transmitted by the femoral head to the acetabulum. The degree of adduction of the flexed leg determines the size of the fragments. If the leg is abducted, the posterior column of the acetabulum will fracture or the acetabulum will protrude into the pelvic cavity due to trauma, but the femoral head will not be damaged. Thus three presentations are possible.

#### Hip at 90° flexion – forced adduction

In this position, the compression forces in the femur axis are parallel to the posterior wall of the acetabulum (Fig. 1). This is when pure hip dislocation occurs. However, either during the dislocation or the reduction, especially when the posterior wall of the acetabulum is fractured, osteochondral

fragments could break off, which would result in a fracture-dislocation of the femoral head. The fragments can lodge themselves in the intra-articular space and lead to early onset osteoarthritis. These foreign bodies are hard to detect on radiographs, thus CT scan is required [7].

#### Hip flexed – neutral adduction

In this position, the compression forces in the femur axis are perpendicular to the posterior wall of the acetabulum (Fig. 2). This is the mechanism for dislocation with fracture of the posterior wall of the acetabulum. The medial part of the head experiences shear forces. With this mechanism, if the posterior wall does not yield, a supra-foveal fracture of half the head may occur, with the detached fragment being on the inferior side of the head. In most cases, this inferior fragment remains inside the joint as it is retained by the ligamentum teres. With this ligament intact, the vascularisation of the inferior fragment of the head is preserved. But a combined injury is still possible: fracture of half the femoral head and fracture of the posterior wall of the acetabulum. The femoral neck can also be completely fractured with the trauma or during reduction attempts.

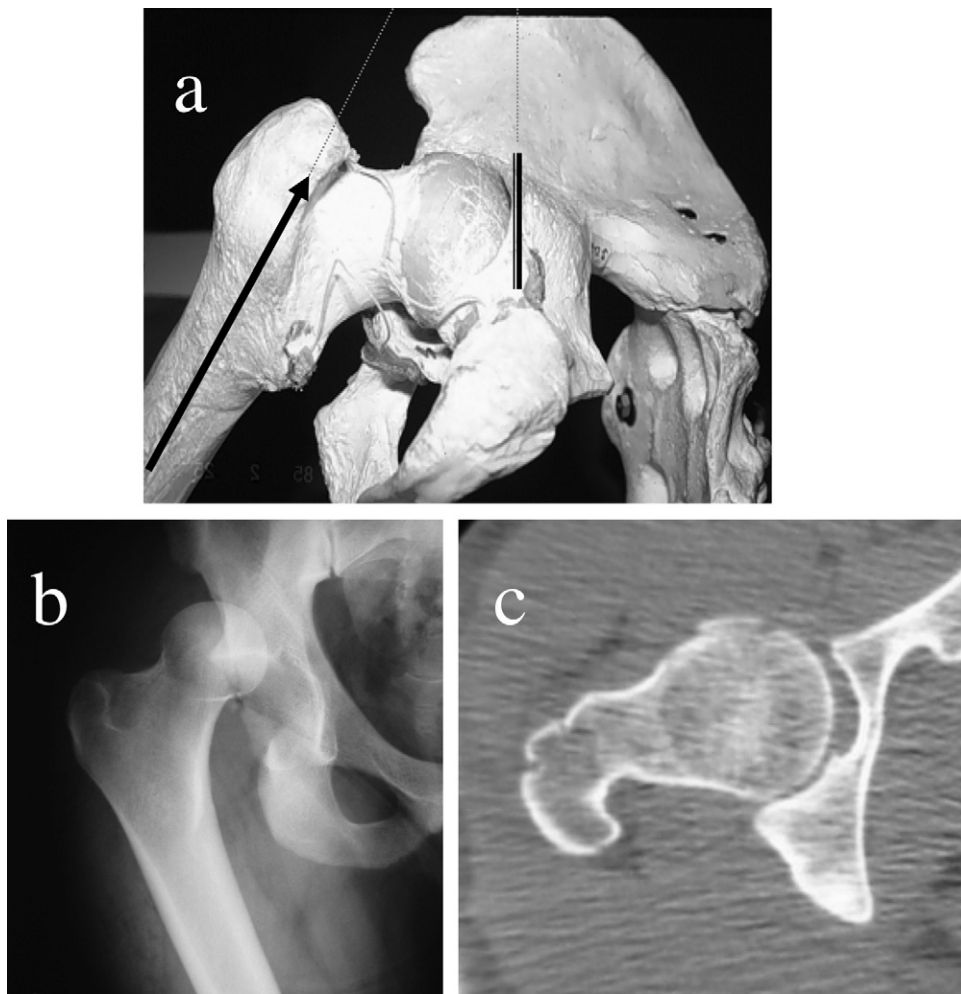
#### In an intermediate adduction position

In this position, the shear forces pass through the anterior-inferior part of the head, at or above the fovea (Fig. 3). With more adduction, the fragment is smaller, thus either one-quarter head or one-third head size fragments. A fracture of the posterior wall of the acetabulum often occurs in combination with this size of head fragments.

### Nerve injury mechanisms

The following observations were made on a series of 90 cases of sciatic nerve palsy taken from a published report [8] and those from our department. Paralysis of the sciatic nerve is rare during pure dislocation (1%) and isolated femoral head fractures (1%); they are common when the posterior wall of the acetabulum is fractured (24%). This can be attributed to nerve trunk injuries, nerve root injuries or both. Nerve trunk paralysis is most often complete; nerve root paralysis can be either dissociated or complete; in the latter case, the tibial nerve recovers early and consistently, but the recovery of the common peroneal nerve occurs later on or not at all. Decoulx et al. [8] attributed this difference to the fibres of the tibial nerve exiting a large sacral hole, having a direct trajectory to the sciatic notch and not being under tension. The fibres of the common peroneal nerve are bulkier, exit a smaller intervertebral foramen, split up on each side of the foramen and the sacral promontory, and are directly under tension (Fig. 4).

We performed an experimental cadaver study to determine the injury mechanism for the sciatic nerve during posterior hip dislocation. An anatomical assessment of the position of the sciatic nerve when the hip is flexed at 90° and in various amounts of adduction was performed. A dynamic study of hip dislocation secondary to compression loading was also performed on materials testing system. In all the scenarios, the sciatic nerve is stretched when the hip is flexed 90°. The stretching forces are transmitted to the



**Figure 1** Injury mechanism: osteochondral fragments a: forced adduction; b: posterior dislocation; c: type I: osteochondral fragments.

roots of the lumbosacral plexus, which is the cause of the positive straight leg-raising test (Lasègue sign). The type of nerve injury varies depending on the position of the leg in abduction.

#### In 90° flexion – forced adduction

In this position, the nerve is medialized and sits between the posterior wall of the acetabulum and the ischium, inside the dislocation axis. It can be partially compressed by the anterior-inferior border of the dislocated head, which would result in ischemia and complete paralysis of both nerve trunks (Fig. 5).

The dislocation secondary to compression loading occurs in two steps. In the first step, the capsule resists the loads and is reinforced by the tenodesis effect of the obturator externus and internus muscles in the cadaver. A load of 16,000 N is required to tear the capsule. The femoral head then dislocates above the sciatic nerve, without injuring it (Fig. 6). Once the compression is removed, the head comes to rest against the nerve and compresses it. This can explain the occurrence of secondary sciatic nerve paralysis when more than 6 hours pass before the hip is reduced.

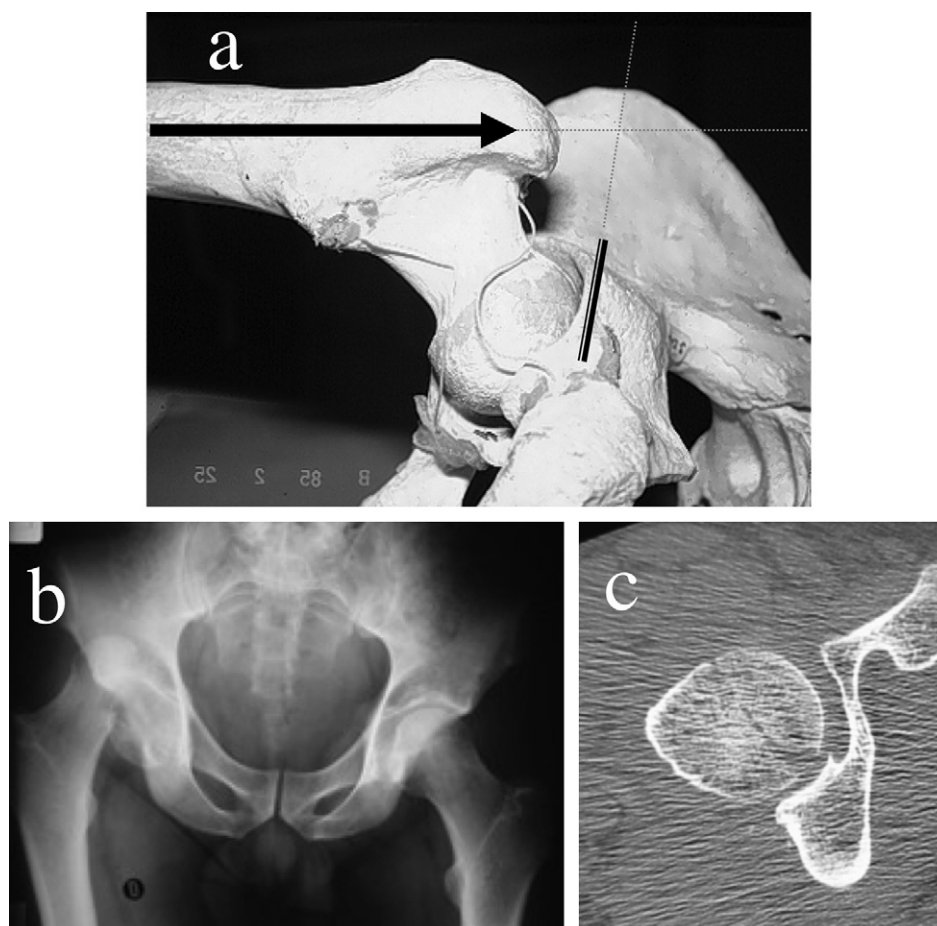
#### Hip at 90° flexion – neutral position

In this position, the nerve is lateralized and sits behind the posterior wall of the acetabulum, opposite the dislocation area (Fig. 7). The dislocation secondary to compression loading occurs in three steps.

In the first step, the capsule and posterior wall of the acetabulum withstand the compression until a load of 20,000 N is applied. In the second step, the posterior wall of the acetabulum fractures. A fragment from the wall is pulled outside the neighbouring capsule, which puts a shear load on the nerve and results in a nerve trunk injury (Fig. 8). The sciatic nerve stays trapped against the head because the obturator externus and internus muscles are interposed between the head and the nerve (Fig. 9). The significant stretching that occurs results in a nerve root type injury. In the third step, after an additional 500 N compression load, the tendons dislocate either upwards or downwards and release the sciatic nerve (Fig. 10).

#### Classification systems

Most classification systems were established based on observations alone, before CT scanning became systematic in the



**Figure 2** Injury mechanism: supra-foveal fracture of half the head. a: neutral position; b: supra-foveal fracture of half the head; c: type IV.

ED. In our opinion, these systems are incomplete and open to criticism, which led us to propose a new classification system that takes into account the size of the fragments and any associated injuries; this system was established based on our series of patients who received a CT scan in the ED.

### Pipkin Classification (1957) [9]

This system describes the fracture shape based on the presence of fairly large bone fragments and the potential presence of either an acetabular wall fracture or a femoral neck fracture (Fig. 11). However, it does not describe all the possible types of bone fragments, especially osteochondral fragments and impacted fractures; also, one-quarter or one-third head fragments are not classified individually. The direction of the fracture line for the one-half head fragment does not correspond to the real scenario. Also, when there is an associated acetabular fracture, the size of the head fragments does not matter any more, since all the cases are grouped into the same type.

### Yoon Classification (2001) [10,11]

A more recent classification system, it describes the various fragments better since it takes into account individual

infra-foveal fragments that are one-third head or one-quarter head in size and extra-foveal fragments that are one-half head in size (Fig. 12). However, this system does not take into account osteochondral fragments, the direction of the fracture line for the half-head fragments is not precise and most importantly, there is no mention of associated acetabular or femoral neck fractures.

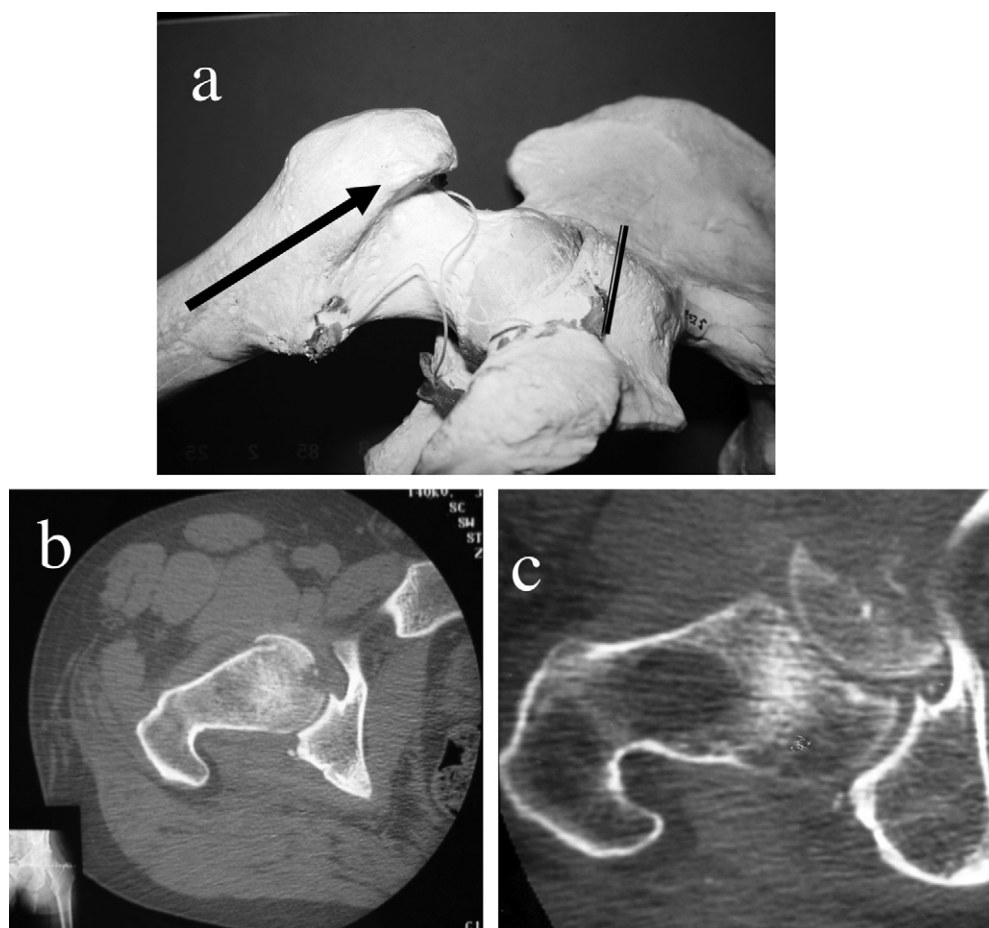
### AO Classification [12]

This follows the typical AO system where numbers are attributed based on the bone involved, the location of the fracture on this bone and a colour code depending on the difficulty. Other than the fact that it is difficult to imagine a fracture being described by a number, this classification scheme does not take into account the existence of osteochondral fragments, does not correctly describe the size of the fractured intra-foveal fragments and especially, does not take associated posterior wall or acetabular fractures into consideration.

### Chiron Classification (2004) [3,5]

In this scheme, the fracture types are described based on the size of the fragments and then placed into either group A, B





**Figure 3** Injury mechanism: infra-foveal fracture of one-third or one-quarter of the head. a: intermediate adduction; b: infra-foveal dislocation; c: type III: one-third of head.



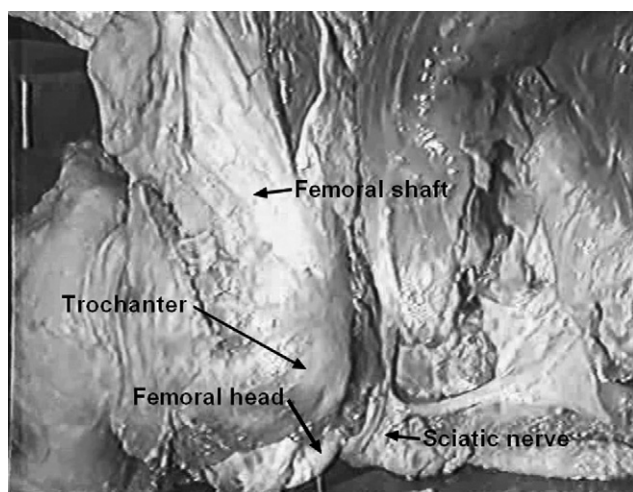
**Figure 4** L5-S1 lumbosacral plexus.



**Figure 5** Right hip in forced adduction: medialisation of sciatic nerve.

or C, depending on if the dislocation is isolated, associated with an acetabular fracture or associated with a femoral neck fracture (Fig. 13, Table 1).

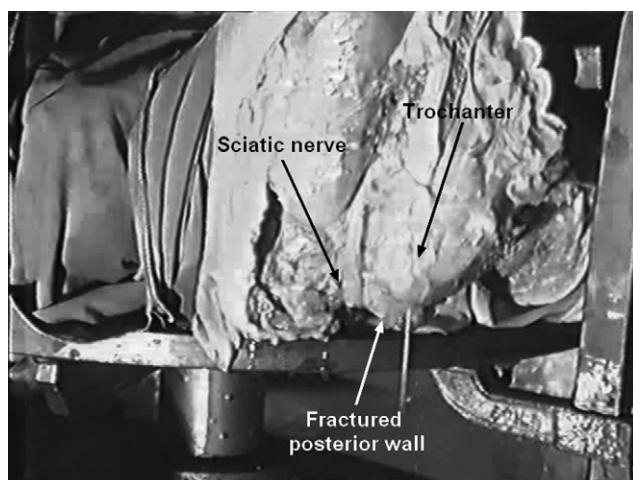
The distribution revealed that intra-foveal type 1, 2, and 3 fractures are most common. Among these fractures,



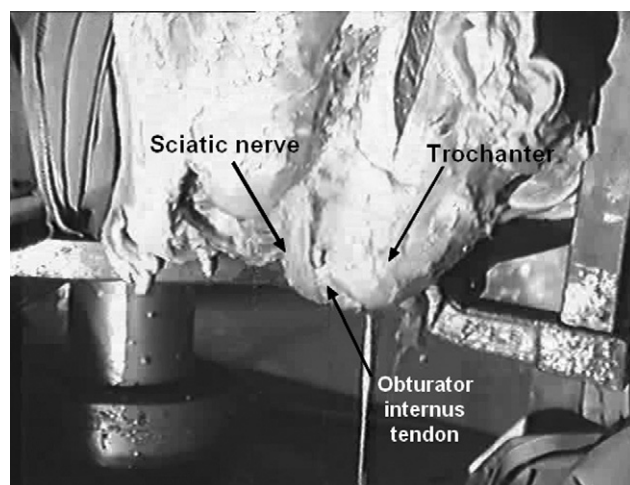
**Figure 6** Right hip flexed in forced adduction: dislocation due to compression force outside of the sciatic nerve.



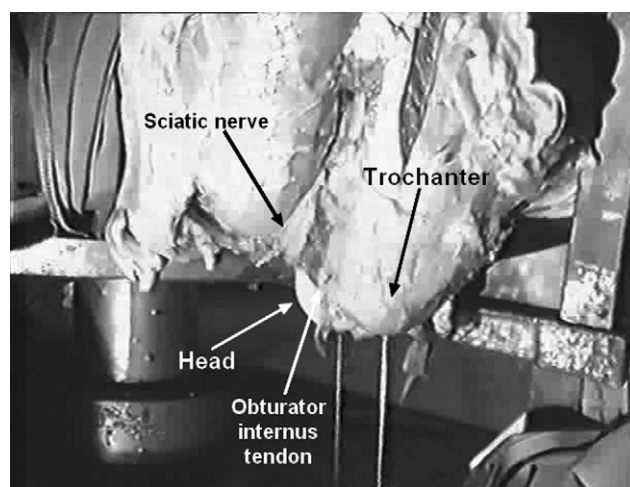
**Figure 7** Right hip flexed in neutral rotation: lateralisation of sciatic nerve.



**Figure 8** Left hip in neutral rotation: dislocation due to compression force; the sciatic nerve is sheared by the wall fragment and stretched.



**Figure 9** Stretching of the sciatic nerve that is trapped in front on the head by the tendon of the obturator internus muscle.



**Figure 10** Dislocation of the obturator tendon which releases the sciatic nerve.

osteochondral fractures are present in almost one-third of patients, but they would not even be seen if a CT scan had not been performed! Fractures with superior subchondral collapse are rare. Associated posterior wall fractures are quite common; they happen with all types of femoral head fractures. The association with a neck fracture is rarer, and are limited to type IV femoral head fracture-dislocations, thus fractures of half the head.

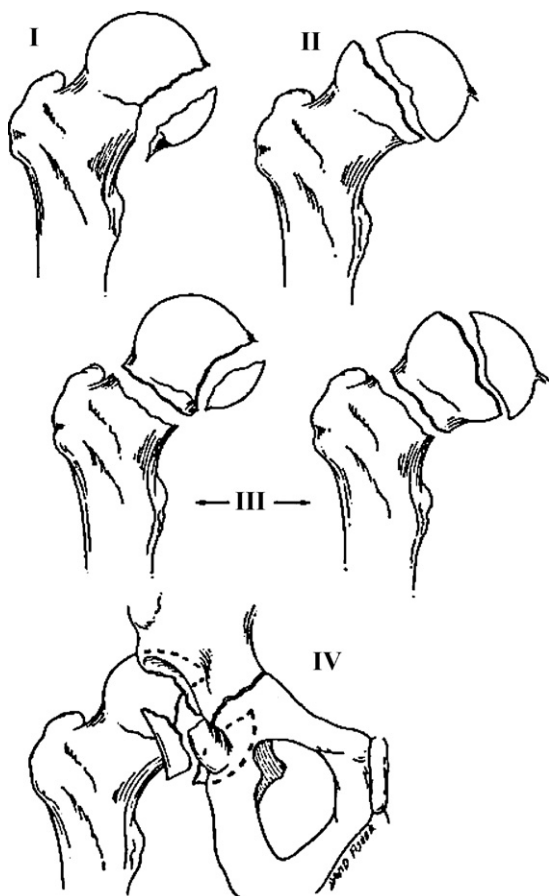
The correspondence between the various classification systems is shown in [Table 2](#).

### Course of action

When a patient presents with significant pain and with the hip in flexion, abduction and internal rotation, the surgeon must recognize a hip dislocation on A/P radiographs: upward migration of the femoral head with rupture of Shenton's line and small trochanter not visible due to the internal rotation. On this A/P view of the dislocated hip, the perimeter of the head must be carefully examined to look for a loss of

**Table 1** Chiron classification: case series.

Group/type (%)	Isolated 19 cases/34.9 (%)	B + acetabular wall 32 cases/58.1 (%)	C + neck fracture 4 cases/7.9 (%)
Type I (29)	3 cases/5.4	12 cases/21.8	1 case/1.8
Type II (32.6)	5 cases/9	13 cases/23.6	0
Type III (20)	7 cases/12.7	4 cases/7.2	0
Type IV (16.2)	4 cases/7.2	2 cases/3.6	3 cases/5.4
Type V (2.2)	0 case/0	1 case/2.2	0/0

**Figure 11** Pipkin classification (1957).

sphericity at its inferior edge, and the presence of a head fragment in the back of the acetabulum or a fracture of the now clearly visible walls. The diagnosis of a femoral head fracture can be made based on the A/P radiographs in most cases (Fig. 14).

### In an emergency setting

#### Reduction of the dislocation

It is advisable to look for a potential femoral neck fracture when a type IV supra-foveal fracture is found, especially in elderly, osteoporotic patients; if the risk exists, then a total hip replacement can be performed immediately in the ED. In all the other cases, the first step in the ED consists of reducing the dislocation, preferably within 6 hours. To reduce the dislocation, apply traction along the femoral axis with the

**Table 2** Correspondence between the various classification systems.

Chiron (2003)	Pipkin (1957)	Yoon (2001)	AO (1987)
Type I	?	?	?
Type II	I	I	C12
Type III	II	II	?
Type IV	II	III	C13
Type V	?	IV	C22
Group B	IV	?	?
Group C	III	?	C31, C32, C33

hip flexed at 90° and in forced adduction and internal rotation. This manoeuvre is well-known since it is the same one used to reduce a total hip arthroplasty performed through a posterior approach. The amount of traction required can be significant. It is advisable to completely stabilize the patient's pelvis, wait for gradual reduction and avoid any jerky movements. Of course, it is understood that the patient must be anaesthetized and curarized.

Three scenarios are possible during the reduction attempt.

*The dislocation cannot be reduced.* The reduction technique is incorrect! A junior surgeon should not hesitate to call upon a more experienced surgeon for help. This could also occur in group A fractures without associated injuries, with a large type III or IV fragment; the cancellous bone in the head creates a notch in the posterior wall, which could have caused the fracture, especially in type IV [13].

*The dislocation cannot be controlled.* This scenario mostly happens when there is a large posterior wall fragment (group B). Temporary traction or an immediate open procedure should be considered.

*The dislocation has been reduced.* The typical sensation of reduction with recovery of joint range of motion while under anaesthesia suggests that reduction has been obtained. However, radiographs should always be performed in the ED to verify that this is truly the case. Temporary traction is not absolutely essential when the hip is stable, but a CT must be requested in the ED at a later time. A surgical procedure must not be performed until the results of this CT scan are known.

#### CT scanning

CT scanning has become an essential assessment. It must be performed in the ED or within 48 hours. The patient's hip cannot be moved or bear weight until the results of this examination have been received. The CT scan is used to determine the size of the fragment and the quality of the



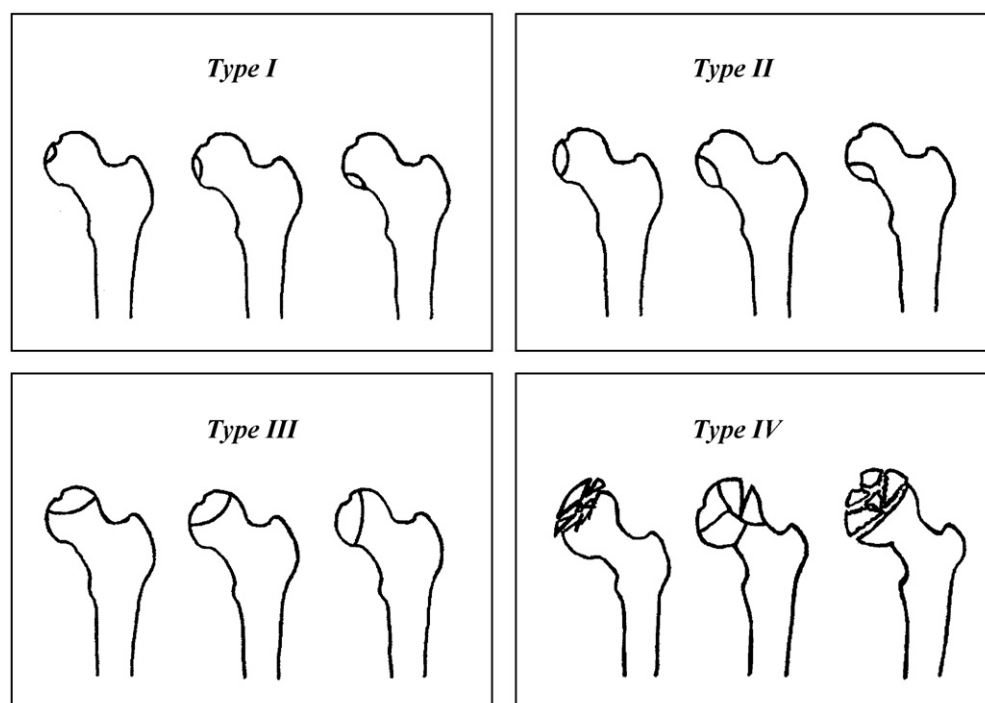


Figure 12 Yoon classification (2001).

reduction, along with the presence of foreign bodies in the joint. Once this information is available, the course of action in the ED began decided on.

### Goals

The goals are to obtain the earliest possible joint mobilisation and return to weight-bearing, while limiting the risk of osteoarthritis later on in patients who are often young at the time of the accident.

### Means

For head fractures, the options are conservative treatment, removal of intra-articular foreign bodies, removal of the femoral head fragment, reduction and internal fixation of a femoral head fragment and total hip joint replacement. For associated fractures, the options are conservative treatment, reduction and internal fixation for posterior wall fractures and hip arthroplasty for neck fractures.

### Surgical approaches

Either a posterior, anterior or medial approach can be used. *The posterior approach.* The posterior approach (75%) is used in the ED for a non-reducible posterior dislocation or when internal fixation is required after reduction of the posterior wall. The advantage of this approach is that the areas containing the injured bone and capsule are directly accessible; the drawback is that the anterior-inferior part of the head is not well exposed in cases of type II or III fracture. *The anterior approach.* The anterior approach (12%), Hueter type or Watson Jones/Rottinger type [14] can be beneficial for non-reducible anterior dislocations, which are actually quite rare [15]. However, screw fixation of a large

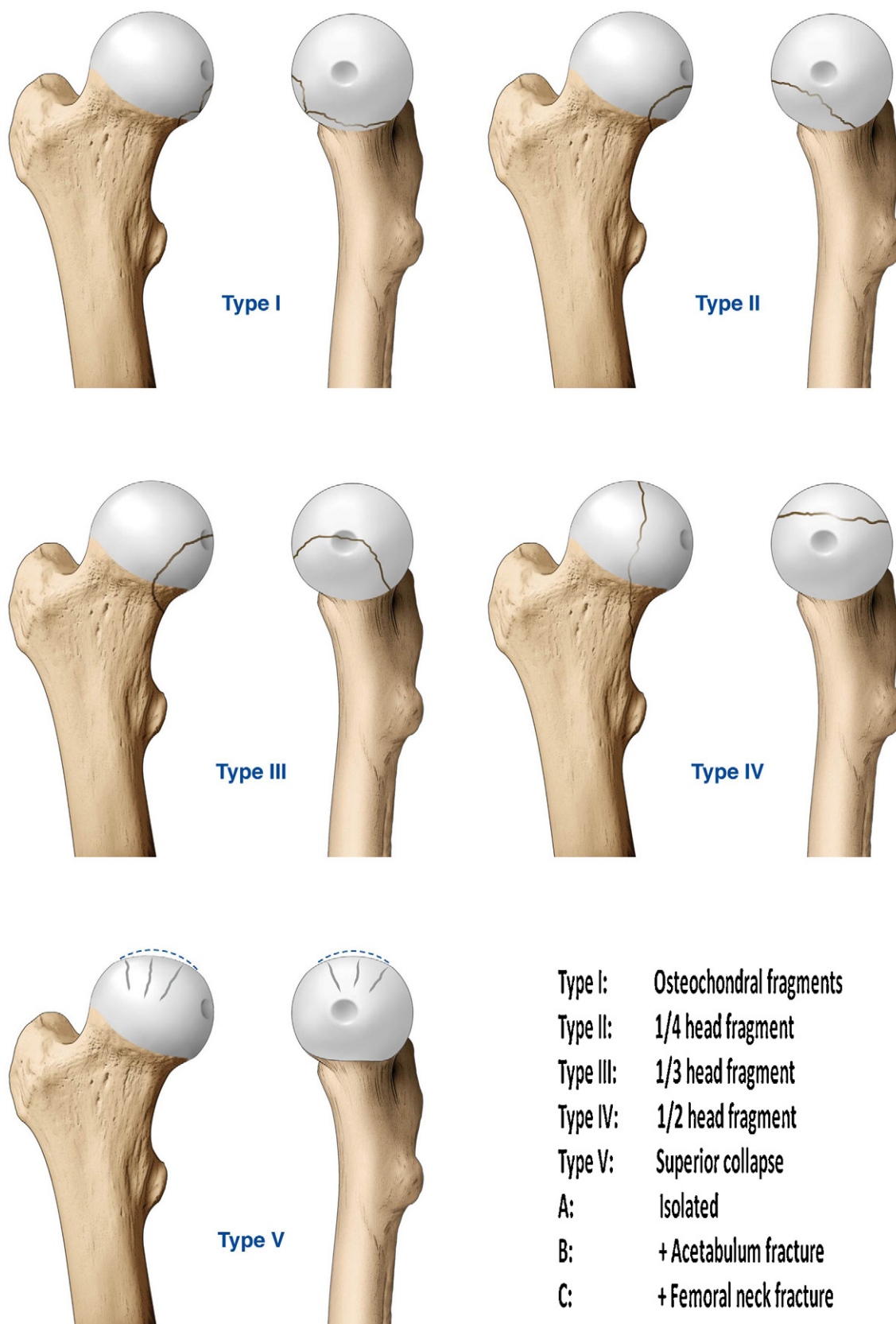
half-head fragment can be easier to perform when using an anterior approach.

*The trans-adductor approaches.* The trans-adductor approaches (13%) are not used often. They were described by Ludloff in 1908, but in insufficient detail to determine exactly which muscle plane were incised [16]. In 1973, Ferguson [17] suggested that Ludloff had probably passed in front of the *adductor longus* and *brevis* and behind the *pectineus* muscles, but he himself suggested passing between the *adductor longus* and *brevis* muscles and the *adductor magnus* muscle. These two approaches only provide a narrow view of the inferior joint capsule and bring about a risk of injury to both the anterior and posterior branches of the obturator nerves. Chiron proposed an approach in front of all the adductor muscles (*longus*, *brevis*, *pectineus*), which was called the "medial hip approach" [2,6]. This provides easy access to the capsule, minimal risk of nerve injury and results in a large exposure, making it possible to perform various surgical procedures. With this surgical approach, a femoral bone fragment that was detached during a femoral head fracture-dislocation can be removed or fixed, either in an emergency setting or in a more chronic case.

### Surgical technique

The patient is placed supine, with the drapes mostly freeing up the inguinal fold. The operated limb is placed in a frog-leg position. The incision is made over the inguinal fold and extended 6 cm along the path of the adductor longus muscle, which is easy to palpate. After dissection, the muscle aponeurosis is opened and then the lateral part is lifted up – it is very important to stop the dissection in front of the muscle aponeurosis, as continuing the dissection would lead directly to the femoral vascular pedicle. Then using either





**Figure 13** Chiron classification (2004).



**Figure 14** A/P radiographs, type III fracture with posterior dislocation.



**Figure 15** Medial approach: psoas tendon is isolated, capsule is incised inside the tendon.

scissors or a finger, all the anterior adductor muscles are separated from the aponeurosis, with no vascular structures in the area. From this position, the lesser trochanter can be palpated with a finger. Double bent Hohmann retractors are placed on either side of the lesser trochanter. At this point, the lesser trochanter is clearly visible with the psoas tendon going from inferior to superior and from inside to outside (Fig. 15). The 45° frog-leg position must be maintained. The psoas tendon is isolated. The Hohmann-Muller spike retractor is then repositioned outside the psoas tendon between the tendon and capsule to move the psoas tendon laterally. The joint capsule is now visible, defined superiorly by the medial circumflex arterial-venous pedicle, which is loosely attached in this position. Carefully continue with the extra-articular dissection of the capsule. A Hohmann-Muller spike retractor is placed under the arterial-venous pedicle and on the anterosuperior part of the acetabulum to expose



**Figure 16** Medial approach: view of the inferior part of the neck and head along with the anterior wall.

the entire upper part of the capsule, up to the side of the anterior wall. The capsule is then opened like a book by making one incision in the axis of the neck and two other incisions, one at the base of the neck and another at the anterior edge of the acetabulum, but without touching the labrum. The view of the joint now encompasses the entire lower half of the femoral head, the entire base of the neck down to the lesser trochanter and the anterosuperior, anterior and inferior parts of the acetabular wall with the labrum (Fig. 16). This minimally invasive surgical approach does not injure any of the muscles.

The only reported complication (five of 64 cases) was a postoperative haematoma due to poor haemostasis in the psoas/gluteus medius/gluteus minimus muscle area or due to a potential injury to the circumflex artery during the procedure.

## Results

All of the procedures performed in this study are shown in Table 3 and described according to the Chiron classification:

- conservative treatment was used in 18 of 55 cases (32.7%) with a range of traction times and unloading periods (30 to 62 days). Nearly all the fragment size types and potential combination with a wall fracture (group B) can be treated conservatively, as long as the post-reduction joint congruency is satisfactory;
- removal was performed in 43.6% of cases, either of a foreign body (20 cases – 36.3%) or head fragments (four cases – 7.2%), with or without internal fixation of the acetabulum; total hip arthroplasty (THA) was performed later on in 14.5% of cases in this category;
- the femoral head fragment was attached by screw fixation in 5.4% (three cases);
- the acetabulum was fixed in 25.4% of cases (14 cases), without taking any procedure on the head or foreign bodies into account;
- primary THA was performed in five cases (9%), all of which were type IV. These immediate joint replacements made up 38.4% of THA in the series;

**Table 3** Results by fracture type and treatment.

Group		Type I			Type II			Type III			Type IV			Type V			OA
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
Number	55 cases	3	12	1	5	13	0	7	4	0	4	2	3	0	1	0	24
Conservative treatment	18 cases	33	31	0	32	4	—	33	2	—	0	0	0	—	0	—	9 cases = 50%
Removal of foreign bodies	11 cases	0	31	0	2	22	—	32	0	—	11	0	0	—	0	—	6 cases = 54%
Removal of head fragment	3 cases	0	0	0	0	21	—	0	0	—	11	0	0	—	0	—	2 cases = 66%
Fixation of acetabulum + Head fragment removal	1 case	0	0	0	0	0	—	0	11	—	0	0	0	—	0	—	1 case = 100%
Screw fixation head fragment	3 cases	0	0	0	0	0	—	1	0	—	11	11	0	—	0	—	2 cases = 66%
Fixation of acetabulum	14 cases	0	1	11	0	3	—	0	0	—	0	0	0	—	0	—	1 case = 28.5%
Fixation of acetabulum + FB removal	9 cases	0	5	0	0	21	—	0	11	—	0	0	0	—	11	—	3 cases = 33%
Fixation of acetabulum + head fixation	0 case	0	0	0	0	0	—	0	0	—	0	0	0	—	0	—	0 case
THA right away	5 cases	0	0	0	0	0	—	0	0	—	1	1	3	—	0	—	—
Osteoarthritis	24 cases	3	2	1	2	4	—	5	2	—	3	1		—	1	—	24 cases = 43.6%
Osteonecrosis	5 cases	0	2	0	2	1	—	1	0	—	0	0	0	—	0	—	5 = 9%
THA later on	8 cases	0	2	0	1	2	—	1	0	—	0	1	0	—	1	—	—

- when a surgical revision was required, a posterior approach was used in 75% of cases; in 10% of cases, osteochondral foreign bodies were removed by arthroscopy;
- there were two types of complications: osteoarthritis in 43.6% of cases and avascular necrosis in 9% of cases (Table 3);
- in this series, osteoarthritis, no matter the stage, was well tolerated since 94% of patients had a WOMAC score between 80 and 100 (out of 100);
- the average Harris score was 89 (range 45–100), thus 85% good and excellent results. This score mostly measures function and pain, with less emphasis on range of motion;
- the PMA ranged from 11 to 18, with a mean of  $16.0 \pm 1.7$ , thus 80% good and excellent results.

## Discussion

The advantages of performing a CT scan have been known for a long time [4]. Few studies on femoral head fracture-dislocation have been published and most of them were performed before use of CT scanning became the standard. This is why we included only patients in our series and those in published series that had a CT scan performed, thus starting in the 1990s.

When conservative treatment can be performed (good reduction, no foreign bodies), this is always the best course of action [10,18].

How should a head fragment be handled? Type I osteochondral fragments, which were the most common (16 cases, 29% of cases), must always be removed if they are in the joint space. This is an ideal indication for arthroscopy, most often using the anterolateral approach [19,20]. Half of the cases progressed to osteoarthritis; in 50% of these cases, the acetabulum had also been fractured (Table 3). For type II and III fragments, the four cases of head fragment removal progressed to osteoarthritis, but the condition was well tolerated (no surgical revision or arthroplasty was needed in the removal cases). Of the three cases of screw fixation of the head, only one subsequently required a THA. Removal of the fragment does not compromise the bone since the lower quarter of the head is not loaded (Fig. 17). With so



**Figure 17** Removal of a type II fragment (quarter-head size); 6 to 8 years.

few cases, it is difficult to endorse either removal [19,21] or reduction and internal fixation as the best means to reduce the risk of head excentration [10], which increases the risk of osteoarthritis over time. Screw fixation of the head did not provide better results than removal [3]. The poor results reported with screw fixation must be tempered because of the challenge associated with this surgical procedure. The minimally invasive medial approach and the anterolateral approach now make treatment easier and this allows us to reconsider the problem of type III fragments, where one-third of the head is detached [22]. It is logical to propose that the head fragment be removed in type II cases. For type IV, the choice is between screw fixation of the large head fragment and primary THA. The decision must take all factors into consideration, including associated fractures, the time elapsed before reduction and the age of the patient [3,23,24].

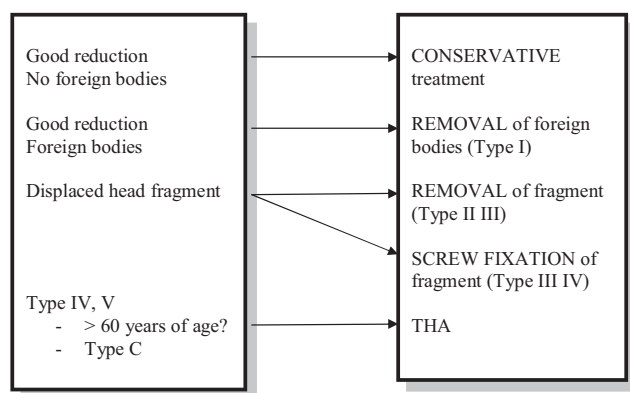
Which surgical approach should be used? The approach must be chosen based on the direction of the dislocation, possibility of an associated posterior wall fracture and also the presence of a fragment that needs to be fixed. A posterior approach was used in 75% of cases, with an anterior approach used in 12% and the medial approach in 13%. However, the current series had a large portion of posterior dislocations and cases requiring acetabulum fixation.

The medial approach seems logical to use in a reduced hip to remove or reduce and fix a head fragment, which is typically anterior, inferior and internal, but this approach does not allow for fixation of the acetabulum [6]. Similarly, arthroscopy, which is only useful in removing foreign bodies, can be performed either by an anterolateral or medial route, depending on the position of the fragments [20]. For the acetabulum, out of 58 cases, there were 34 type B cases (61.8%); mostly this was a fracture of the posterior wall of the acetabulum that did not always require surgical treatment (50% fixation rate out of 34 cases). When the surgeon needs to fix the posterior wall, this will drive the choice of approaches. In the current study, 16 of the 24 cases of type B fracture required internal fixation. Although this group did not progress to osteoarthritis relatively more often than for type A fractures, there was a 60% THA rate since both osteoarthritis and AVN occurred later on. The published literature suggests that there is no link between AVN and acetabular fractures, but these results make us wonder.

Our results also suggest that we should be more aggressive in determining an indication for primary THA. A neck fracture will compromise the vascularisation of the femoral head, thus a THA is indicated no matter the patient's age [20]. Out of the six primary PTH cases, half were for type C fractures. In our study, 78% of THA were for type B and C fractures. The associated neck fracture requires the surgeon to establish the total hip arthroplasty indication, given the numerous poor results reported with internal fixation (62% non-union and 89% avascular necrosis) [18]. In patients above than 50 years of age, 71% got an arthroplasty. Some of these hip replacements can be performed immediately: patient greater than 50 years of age, type C fracture, type IV fracture, reduction after delay of more than 6 hours.

The published rate of hip osteoarthritis [18] varies between studies and was 55% in our study. But despite the high risk of OA with this type of injury, osteoarthritis in the long term is relatively well tolerated; 80% of patients





**Figure 18** Summary of the approach to take.



**Figure 19** Malunion of type II fracture: medial approach used to smooth out head.

maintained their work-related or sports-related activities; the range of motion was normal or nearly normal in more than half the patients; 94% of patients had a WOMAC score between 80 and 100 (out of 100). Based on objective scoring systems, there were 15-20% fair or poor results. These results are not as good as the previous ones, but are acceptable given the severity of the trauma and because overall patient satisfaction is good. The AVN rate was 9%, which was consistent with published reports [25,26], but had no correlation to acetabular fracture or the need for open surgery. As previously shown, only early reduction has a positive effect [27].

Although no definitive conclusions can be made, we were able to set out a course of action to follow for femoral head fracture-dislocations in an emergency setting (Fig. 18).

### Chronic cases

Malunion of the femoral head resulting from a type II or III fragment (quarter or third of head) healing in the wrong position can cause groin pain in the region of the adductor

muscles and can potentially cause a catching sensation. In a second procedure using the medial approach, the shape of the head can be made more even and a capsular arthrol-ysis can be performed with good functional results. Our experience consists of six cases of Tönnis stage 0 or one osteoarthritis that were operated 6 months to 3 years later with completely recovery in all the cases (Fig. 19).

### Conclusion

Femoral head fracture-dislocation is a joint trauma condition with a compromised medium and long-term functional prognosis. For the surgeon on ED duty, these are a true challenge – since this is not a common trauma case, he or she may not have much experience in making this type of treatment decision.

Our proposed simple classification system using CT scan imaging performed in the ED, classifies all types of fractures based on the size of the head fragment and associated injuries (femoral neck and acetabular fractures). Also, modern surgical techniques provide the ability to immediately choose a treatment approach in the ED based on the classification, which takes into consideration the type of femoral head fractures, the age of the patient, the advantage of each treatment choice and the delay in reducing the joint. These elements introduce the idea of a prognosis. By mastering the medial approach in front of the adductor muscles or the Rottinger approach, anterior-inferior fragments of one-third or one-quarter head size can more regularly be removed or reduced and fixed by using a minimally invasive approach.

### Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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